

Electronic Version 1.1

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## Description

# Bilge Pump Monitor with Flow Detection

### SUMMARY

[0001] This apparatus relates to the art of bilge and sump pumps and more specifically to monitoring of the operational status of the pumps in a system. Operators of boats and ships rely on bilge pumps to remove excess water in the bottom or bilge of the vessel. Likewise maintainers of buildings where foundation or other leaks are present, rely on sump pumps to remove unwanted water from lower sections of the building. The operational condition of the sump or bilge pump is vital information for these personnel. The failure of a building sump pump can cause property loss, while the failure of a boat or ship bilge system can cause loss of property and worse, loss of life. It is therefore desirable to know the condition of the sump and bilge systems.

[0002] A bilge or sump pump system of this type will usually include; a pump, an actuator (automatic and/or manual), an inlet screen, an outlet hose, an electric power supply including fusing. These components as well as the pump itself can fail to operate. Components can get clogged up with debris, the pump itself can become corroded and cease to operate. Additionally the automatic actuator can become jammed on or off and a manual switch can be left on accidentally. If the sump or bilge pump runs

continuously, it can prematurely wear out the pump or wear down the battery if a battery is used as the power source. These conditions can and should be monitored to allow ample time to remedy the failure or emergency situation. The present invention provides a unique means of monitoring these conditions

[0003] In the past there have been several methods to monitor and identify the operating condition of such systems. Previous monitoring methods, however, require too much time to elapse before the faulty conditions are revealed.

[0004] There are 2 ways to determine a fault in a bilge or sump system, directly and indirectly. The indirect approach uses a high water indicator. Using the indirect approach, if the system or any part of the system fails, and there is a leak, water will rise in the sump until a high water sensor is activated and a high water alarm alerts the operator of the pending danger. This method is a vital component of a complete emergency sump /bilge warning system because it will alert if all else fails. It does however alert the operator after the water has risen to perhaps emergency levels. It should be relied on as a last resort.

[0005] The direct approach is to warn the operator that the pump system itself is not working properly. This warning will result in an earlier alert that can perhaps be remedied before there is an impending problem. The present invention uses the direct approach by simply verifying that water is indeed flowing from the bilge system when it is supposed to be. Additionally it gives the operator a positive, visual indication that the pumping system is

operating normally.

[0006] The present invention will indicate to the operator.

1. That the pump is on or off (pump state)
2. That water is flowing or not from the outlet of the pump system (flow indication)
3. That the system is calling for pumping but there is no resulting flow (fault indication). This fault indication can mean several things:
  - The pump has been manually turned on and should be turned off
  - The automatic pump activation switch is erroneously indicating water in the sump area. These are usually float switches that can become stuck on.
  - The system is clogged, at the inlet , outlet, hose or the pump itself.
  - The pump is not working due to perhaps due to being jammed or having a bad fuse.
4. Optionally, that the pump has been continuously pumping for a predetermined amount of time that is considered too long (capacity warning). This indicates that the water inflow is more or at least approaching more than the pump can handle.

## BACKGROUND ART

[0007] Patent 6,676,382 recognizes the need to ascertain the condition of the sump pump system but requires an expensive apparatus for monitoring motor speed, motor amps, float position and run time. This approach can

determine if the motor is operating properly but cannot tell if the system is clogged until the water reaches a high water mark which is identified by the high water alarm.

[0008] Patent 6,473,004 approaches the bilge pump condition monitoring by combining high water alarm switches and run time in multiple compartments. Again a clogged condition cannot be determined until emergency levels are encountered.

[0009] Patent 5,672,050 monitors water level and power failure to determine a fault condition in a sump pump.

[0010] Patent 5,467,643 recognizes the need to monitor the flow from a bilge system but fails to utilize the information other than to display the rate of flow.

[0011] 4,187,503, 3,932,853, 4,255,747, 6,375,430, 6,149,390, 6,139,281, & 6,464,531, also are limited to high water alarm condition monitoring. 5,672,050 uses a high water float switch to alarm and control the sump pump. 4,369,438 combines high water and power available to provide status of the sump pump system.

[0012] 4,341,178 monitors the amount of time the bilge system is activated thereby determining the amount of water that is leaking into the bilge. An alarm is initiated when an operator set threshold is crossed. If the pump system was clogged or the actuator was stuck the operator would think that there was a large leak and would have no idea if water was actually being pumped out or not.

[0013] None of the approaches from previous art can determine that the system has failed due to a clogged pump or clogged output hose until either a high water alarm switch is indicated or too much pump time has elapsed. This might be too late for an emergency situation. Additionally none of the previous art will alert if the pump actuator becomes stuck on causing unnecessary wear on pump components. The present invention alerts when:

- The pump system is clogged ( Pump fault visual and/or audible indicator)
- The pump actuator becomes stuck on ( Pump fault visual and/or audible indicator)
- Optionally, the leak is too large for the pump ( Taking on water visual and/or audible alarm)

[0014] An additional advantage to the present invention is to provide visual indication when the pump is activated (Pump on visual indicator) and when water is flowing from the outlet of the pump system (Flow On Visual Indicator). This is similar to 5,467,643 except that less expensive flow detection means can be utilized since it only requires flow or no-flow indication.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

[0015]

Figure 1 depicts the functional view of the sump/bilge monitor. Parts of the system:

- 1 - Flow Detector – This can be a simple flow switch such as the UniProbe Flow-No-Flow Switches, Models UP01 and SP01 or GEMS #165841 or Crydom #FS15. Flow could also be detected by a simple impedance measurement circuit.
- 2 - Pump output hose
- 3 - Pump actuator – This is usually a float switch such as Rule-a-Matic model 35 or 37.
- 4 - Sump or Bilge Pump – many pumps are available for this application including; Rule submersible bilge pumps or Atwood “V” Series Bilge pumps.
- 5 - Power source – Depending on the pump the and the application the power source could be a battery or standard utility supplied AC power.
- 6 - Electronics – This is where the logic of the system is embodied. This part converts the input signals into the output indications and alerts.
- 7 - Display – This is a mechanical means for holding the visual indicators
- 8 - Audible Alarm – Depending on the desired sound level, several different types of audible alarms may be utilized. Such as piezo buzzers or louder alarms such as NORCO SD20W – DSC 20W
- 9 - Flow on visual indicator – This could be a incandescent light bulb or light emitting diode. The color would indicate non alert (green or blue etc.)
- 10 - Pump on visual indicator – This could be a incandescent light bulb or light emitting diode. The color would indicate non alert (green or

blue etc.)

- 11 - Pump Fault visual indicator – This could be a incandescent light bulb or light emitting diode. The color would indicate an alert (red or yellow etc.)
- 12 - Capacity Warning indicator – This could be a incandescent light bulb or light emitting diode. The color would indicate an alert (red or yellow etc.)
- 13 - Flow signal line – An electric signal indicating that flow is detected at the output of the system.
- 14 - Pump status signal line – An electric signal indicating that the pump has been activated either by manual or automatic means.
- 15 - Audible signal line – An electric signal causing the audible alarm to sound.
- 16 - Fuse – A safety electric fuse properly sized to prevent burned out wiring if shorted.

**[0016] Functionality of the system: The Present Invention:**

1. Provides a visual indication that the sump or bilge pump (4) has been actuated automatically or manually. This indicates that power is available to the pump and that it is on by either automatic or manual means.
2. Provides a visual indication that water is actually flowing from the pump system. This is useful when the pump has been actuated manually giving the operator an indication when to turn the pump off.
3. Provides a visual and audible alert when the pump system fails for

any reason. This indicates that the pump has been actuated for certain time period without achieving water flow at the flow detector.

The reasons for the lack of flow could be:

- The pump was manually activated and should be turned off
  - The pump intake is clogged
  - The pump output hose is clogged
  - The pump activator is stuck one
  - The pump fuse is blown
4. Provides a visual and audible indication that the boat is taking on too much water. This alert is indicated that the pump has been properly producing flow for greater than a predetermined amount of time (nominally 2 minutes). This is an emergency situation that warrants immediate action to fix the leak.

[0017] Figure 2 depicts the design of the sump/bilge monitor. Additional parts of the sump/bilge monitor:

- 20 – Pump Fault Timer (Nominally 5-10 seconds).
- 21 – Flow Detector Circuit. This could be a simple impedance measurement circuit or even simpler if a flow switch is utilized.
- 22 – Capacity Warning Timer ( nominally 2 minutes).
- 23 – signal line from flow detection circuit (21) to Capacity Warning Timer (22)
- 24 – signal line from the pump fault timer (20) to the pump fault visual indicator(11)
- 25 – signal line connecting directly from the pump status signal line



(14) to the pump on visual indicator (10)

- 26 – signal line connecting from the Flow detection circuit (21) to the Flow on visual indicator
- 27 – signal line from the capacity warning timer to the capacity warning visual indicator

[0018] Normal operational design

[0019] A high signal on the pump status signal line (14) indicates that the pump is on or at least that the actuator (3) is calling for the pump to be on. This signal causes the pump fault timer (20) to be activated and start its timing. This timer is predefined but is nominally 5 - 10 seconds. That is as long as the pump status signal line goes low before the predefined amount of time (5-10 seconds), the timer will reset. It also causes the signal line (25) to go high and therefore the pump on visual indicator (10) to turn on.

[0020] If all is well, the pump being on will cause water to be pumped to the flow detector (1) to output a signal on the flow signal line (13). The flow detection circuitry will cause this signal to be turned into a digital logic signal high on the signal line (23). The high logic on signal line (23) cause the capacity warning timer to start timing. It also causes the flow on visual indicator (9) to turn on.

[0021] Normally when sump area empties, the pump actuator (3) turns off the pump and the pump status signal line (14) goes low. This low signal causes the pump on visual indicator (10) to turn off and the capacity warning timer (22) to reset.

[0022] Since the pump is off, the flow stops thereby causing the flow detector to not detect flow so the flow signal line (13) goes off which causes the flow detector (21) to output a low on the signal line (23). It will also cause the flow on visual indicator to turn off.

[0023] That is that if the pump status signal line stays high for greater than the predefined time (5-10 seconds) the output on signal line 24 will go high and the pump fault visual indicator (11) will turn on.

[0024] **Normal Operation of the Pump:** Whenever the pump actuator (3) senses water in the sump and causes the sump or bilge pump (4) to turn on. The electronics (6) senses the activation status in the flow signal line (13) and activates the pump on visual indicator (10). Water is pumped through the pump output hose (2) to the flow detector (1). When water reaches the flow detector (1), a signal is sent to the electronics (6) via the flow signal line (13). Sensing a signal on the flow signal line (13) the electronics (6), causes the flow on visual indicator (9) to illuminate. When the water returns to a certain level, the pump actuator (3) deactivates the sump or bilge pump (4). The electronics (6) senses that the sump or bilge pump (4) is off on the pump status signal line (14) and turns off the pump on visual indicator (10). The electronic (6) also senses that now flow is occurring on the flow signal line (13) and turns off the flow on visual indicator (9).

[0025] **Description of system operation during a pump fault condition:** Pump actuation occurs as in the normal operation however in the pump fault operation case, no water is detected at the flow detector (1). When a predetermined amount of time elapses (e.g. 5-10 seconds) after the sump

or bilge pump (4) was actuated and no flow was detected at the flow detector (1) a fault is indicated on the on the pump fault visual indicator (11). This condition also causes the audible alarm (8) to sound by actuating the audible signal line (15). The placement of the fuse (16) protects the circuit but does not interfere with the signal from the pump actuator (3) via the pump status signal line (14) in case of fuse failure.

[0026] **Description of the system during an extreme leak condition:** Pump and visual indications occurs as in the normal operation where the Flow on visual inaction and the pump on visual indicator are activated. If water continues to flow for greater than a predetermined time period (e.g. 2 minutes), the Capacity Warning visual indicator (12) is illuminated and the audible alarm (8) sounds. This condition indicates that the influx of water has exceeded the ability of the sump or bilge pump (4) to remove it.